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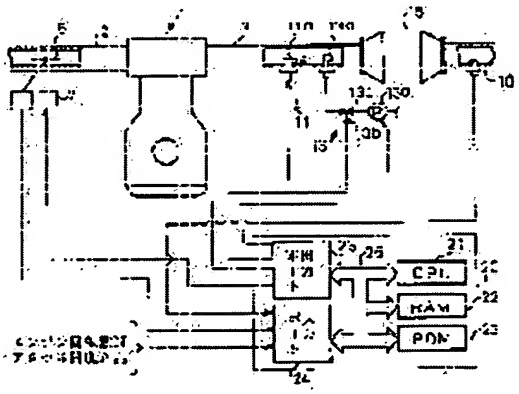
(54) EXHAUST EMISSION CONTROL SYSTEM FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PURPOSE: To prevent responsiveness to reducer supply volume control for an NOx absorbent from deteriorating caused by reduce sticking to a wall surface if a liquid-like reducer is used, in an exhaust emission control system in which the NOx absorbent is located in an engine exhaust passage, and in which the reducer is fed into the NOx absorbent.

CONSTITUTION: A reducer supply device 11 and a secondary air introduction device 13 are provided in an exhaust passage 3, upstream of an NOx absorbent 15, and an oxygen density sensor 10 is located in the exhaust passage 3, downstream of the NOx absorbent 15. An electronic control unit 20 feeds a reducer by a supply volume in excess of a volume necessary for regeneration of the NOx absorbent 15, from a reduce supply device 11, and performs feed-back control of the air volume introduced from the secondary air introducing device 13 in accordance with an oxygen density detected by the oxygen density sensor 10 so as to set the air-fuel ratio of exhaust gas flowing into the NOx absorbent 15 is maintained in a predetermined range. Since the density of the reducer in the NOx absorbent is controlled by the secondary air volume, the control responsiveness and the control stability can be enhanced in comparison with such control that the density of the reducer is controlled by the reducer supply device 11.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] To the flueway of the internal combustion engine which burns the Lean air-fuel ratio in most engine operating range at least It is NOX when the air-fuel ratio of inflow exhaust air is Lean. NOX which was absorbed, and was absorbed when the oxygen density of inflow exhaust air fell NOX to emit An absorbent is arranged. A reducing agent is introduced during exhaust air under a predetermined service condition, and it is said NOX. NOX absorbed from the absorbent It is this NOX while making it emit. In the exhaust emission control device of the internal combustion engine which does reduction purification Said NOX NOX absorbed at least to the absorbent A reducing-agent supply means to supply the reducing agent of the above amount needed for reduction purification, It is said NOX at the time of said reducing-agent supply. A secondary air installation means to introduce the secondary air into the flueway of the absorbent upstream, Said NOX An oxygen density detection means to detect the oxygen density under exhaust air of the absorbent downstream, Based on the detected oxygen density, the amount of secondary airs of said secondary air installation means is adjusted, and it is said NOX. Exhaust emission control device of the internal combustion engine characterized by having the control means which controls the air-fuel ratio of the exhaust air which flows into an absorbent in the predetermined range.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is NOX under exhaust air of internal combustion engines which burn the Lean air-fuel ratio in most operating range, such as a gasoline engine which carries out a diesel power plant and lean combustion to a detail, about an internal combustion engine's exhaust emission control device. It is effectively related with a removable exhaust emission control device.
[0002]
[Description of the Prior Art] As an example of this kind of exhaust emission control device, there are some which were indicated by the Provisional-Publication-No. 62-No. 106826 official report, for example. The equipment of this official report is NOX under existence of oxygen to a Diesel engine's flueway. The absorbent (catalyst) to absorb is arranged and it is NOX under exhaust air. It is made to absorb and is NOX of this absorbent. By intercepting the inflow of the exhaust air to an absorbent and supplying a gas-like reducing agent to an absorbent, when absorption efficiency falls, it is an absorbent to NOX. NOX emitted while making it emit Reduction purification is carried out.
[0003]
[Problem(s) to be Solved by the Invention] With the exhaust emission control device of the above-mentioned Provisional-Publication-No. 62-No. 106826 official report, it is NOX. NOX from an absorbent In order to perform emission and reduction purification (henceforth "playback"), it is NOX about gas-like reducing agents, such as hydrogen. The absorbent is supplied. However, the reducing agent of the shape of a gas, such as hydrogen, produces various problems, when there is a problem with difficult handling, such as needing a special container on the occasion of storage, and it uses it especially for the internal combustion engine for cars.
[0004] Therefore, NOX It is desirable that liquid fuel used for the internal combustion engine concerned, such as a gasoline and gas oil, can be used as they are as a reducing agent used for playback of an absorbent. However, liquid fuel, such as a gasoline and gas oil, contains many components from which the boiling point differs, and the amount of the fuel evaporated with temperature changes. For this reason, if such liquid fuel is supplied to an exhaust air system as they are, it will remain without some fuels evaporating according to an exhaust-gas temperature, and the problem which adheres to a flueway wall surface while it has been liquefied is produced. These wall surface adhesion fuels are also transmitted to a flueway wall surface, and drop off, and, finally it is NOX. It reaches and evaporates [burn and] to an absorbent. However, NOX It is NOX by the time it reaches an absorbent. It is NOX after pouring a reducing agent into an exhaust air system, since the time of concentration which changes according to the distance and the exhaust air rate of flow to an absorbent is needed. By the time the reducing agent of the specified quantity is obtained with an absorbent, a time lag will arise.
[0005] In order to prevent this, in consideration of wall surface coating weight, the reducing agent more than an initial complement is beforehand poured into an exhaust air system, and it is NOX in early stages. It is also possible to increase the amount of the evaporation component which reaches an absorbent. However, the reducing agent which adhered to the wall surface in this case is NOX after the above-mentioned time delay progress. If an absorbent is reached, the amount of a reducing agent will become superfluous, and it is NOX. Since the air-fuel ratio in an absorbent part becomes

rich, it is NOX. Ammonia is generated with an absorbent or there is a possibility that it may be emitted to atmospheric air, without consuming HC of a reducing agent, CO component, etc.
[0006] For this reason, liquefied reducing agents, such as gas oil, are used and it is NOX. Wall surface adhesion and NOX of an above-mentioned reducing agent when reproducing an absorbent The attainment delay to an absorbent is taken into consideration, and it is NOX. It is necessary to change the reducing-agent amount of supply with time amount so that the reducing agent of a predetermined flow rate may always reach an absorbent. However, wall surface coating weight and NOX of a reducing agent The attainment time delay to an absorbent changes with service conditions, such as an exhaust-gas temperature and the exhaust air rate of flow, a lot. Therefore, when using a liquefied reducing agent, even if it was the case where it will be necessary to control the reducing-agent amount of supply finely according to these conditions, and there was a problem which a control network complicates, and the reducing-agent amount of supply was controlled correctly, since there was a time delay by above-mentioned wall surface adhesion, there was a problem with it difficult [to raise the responsibility and stability of control].
[0007] If it is made to pour into an exhaust air system after atomizing to extent which pours into an exhaust air system or does not produce wall surface adhesion after making a liquefied reducing agent evaporate completely beforehand, the above-mentioned problem at the time of using a liquefied reducing agent is solvable to some extent. However, since for that the special device for evaporation of a reducing agent or atomization is needed, there is a problem which causes complication of equipment and the increment in cost.
[0008] In view of the above-mentioned problem, the problem about above-mentioned liquefied reducing-agent use is solved, without forming the special equipment for evaporation of a reducing agent, or atomization, the responsibility and stability of reducing-agent amount-of-supply control are raised, and this invention is NOX. It aims at offering the exhaust emission control device which can perform efficient playback of an absorbent.
[0009]
[Means for Solving the Problem] According to this invention, as shown in the block diagram of invention of drawing 1 , to the flueway of the internal combustion engine which burns the Lean air-fuel ratio in most engine operating range at least It is NOX when the air-fuel ratio of inflow exhaust air is Lean. NOX which was absorbed, and was absorbed when the oxygen density of inflow exhaust air fell NOX to emit An absorbent is arranged. A reducing agent is introduced during exhaust air under a predetermined service condition, and it is said NOX. NOX absorbed from the absorbent It is this NOX while making it emit. In the exhaust emission control device of the internal combustion engine which does reduction purification Said NOX NOX absorbed at least to the absorbent A reducing-agent supply means A to supply the reducing agent of the above amount needed for reduction purification It is said NOX at the time of said reducing-agent supply. A secondary air installation means B to introduce the secondary air into the flueway of the absorbent upstream Said NOX An oxygen density detection means C to detect the oxygen density under exhaust air of the absorbent downstream Based on the detected oxygen density, the amount of secondary airs of said secondary air installation means is adjusted, and it is said NOX. The exhaust emission control device of the internal combustion engine characterized by having the control means D which controls the air-fuel ratio of the exhaust air which flows into an absorbent in the predetermined range is offered.
[0010]
[Function] At the time of reducing-agent supply, the reducing-agent supply means A is always NOX. The reducing agent more superfluous than a complement to absorbent playback is introduced into exhaust air, and control of the precise reducing-agent amount of supply is not performed. Based on the oxygen density which the oxygen density detection means C detected, a control means D carries out feedback control of the introductory air content of the secondary air installation means B, and is NOX. The air-fuel ratio of the exhaust air which flows into an absorbent is maintained in the predetermined range. Thereby, it is NOX irrespective of the amount of the reducing agent adhering to a wall surface. It is NOX while the reducing agent of an initial complement is always supplied to an absorbent. The responsibility and stability of Air Fuel Ratio Control of exhaust air which flow into an absorbent part improve.
[0011]

[Example] With reference to drawing 2 , the example at the time of applying this invention to a diesel power plant is explained. In drawing 2 , in 1, a diesel power plant and 2 show an engine inlet pipe, and 3 shows an engine exhaust pipe. In this example, the shutter bulb 6 is formed in the engine inlet pipe 2.

[0012] It is the format of a butterfly valve with little inhalation-of-air resistance at the time of full open, and is held at full open at the time of usual operation of an engine, and the shutter bulb 6 is the below-mentioned NOX. NOX absorbed by the absorbent Clausilium is carried out to predetermined opening at the time of emission and reduction actuation, and the air content which extracts an inlet pipe 2 and is inhaled by the engine is reduced. The actuator of proper formats, such as a step motor which carries out the closing motion drive of the shutter bulb 6 in response to the signal from the electronic control unit (ECU) 20 of the after-mentioned [7], and a negative pressure actuator, and 8 are opening sensors which detect the opening of a shutter bulb.

[0013] Moreover, the pulse air induction reactor 13 is arranged at the reducing-agent feeder 11 and its downstream at the engine exhaust pipe 3, and an exhaust pipe 3 is NOX at the downstream further. It connects with casing which held the absorbent 15. Moreover, NOX In the flueway of absorbent 15 outlet, it is NOX. The oxygen density sensor 10 which detects the oxygen density under exhaust air which passes an absorbent is formed.

[0014] The reducing-agent feeder 11 is NOX. The exhaust pipe 3 of the upstream of an absorbent 15 is equipped with injection valve 11a which injects a reducing agent, and the reducing agent of a predetermined flow rate is poured in into an exhaust pipe 3 according to the input signal from ECU20. Liquid fuel, such as a hydrocarbon of liquids, such as a propane, a propylene, and butane, or a gas, a gasoline, gas oil, and kerosene, etc. can be used that what is necessary is just what is exhausting and generates reduction components, such as a hydrocarbon and a carbon monoxide, as a reducing agent. However, the gas oil same as a reducing agent in this example as an engine fuel is used from the above-mentioned reason, and gas oil is pressurized by the feed pump from the fuel tank of the engine which is not illustrated, and is supplied to injection valve 11a.

[0015] The pulse air induction reactor 13 is equipped with flow-control-valve 13c which has actuator 13b, such as source of pressurization air supply 13a, such as an electric rotary pump, and a stepper motor, and nozzle 13d, drives actuator 13b of flow-control-valve 13c with the control signal from ECU20, changes the opening of flow-control-valve 13c, and can adjust now the flow rate of the secondary air introduced into an exhaust pipe 3 from nozzle 13d.

[0016] The RIN mixture sensor which outputs the signal which changes continuously according to the oxygen density under exhaust air is used for the oxygen density sensor 10. However, in this example, since ON/OFF control of the flow-control-valve 13c is carried out like the after-mentioned, the sensor of the type with which an output changes suddenly near the theoretical air fuel ratio as an oxygen density sensor 10 may be used. Moreover, it is the electronic control unit (ECU) of an engine 1 which is shown in drawing by 20. ECU20 consists of a digital computer of a configuration of having connected CPU21, RAM22, ROM23 and input port 24, and an output port 25 mutually with the bi-directional bus 26, and performs basic control, such as fuel-oil-consumption control of an engine, and also it is performing control of playback actuation of a NOX absorbent etc. in this example. For these control, the opening signal of the shutter bulb opening sensor 8 to a shutter bulb is inputted, respectively, and also the oxygen density signal under [the oxygen density sensor 10 to] exhaust air is inputted into the input port 24 of ECU20 again from the sensor which signals, such as an engine speed, accelerator opening, and an exhaust-gas-temperature signal, do not illustrate, respectively.

[0017] NOx An absorbent 15 makes an alumina support and is Potassium K, Sodium Na, Lithium Li, and Caesium Cs on this support. Alkali metal [like] and barium Ba, Calcium calcium At least one chosen from an alkaline earth [like], Lanthanum La, and rare earth like Yttrium Y, and platinum Pt Noble metals [like] are supported. This NOX An absorbent 15 is NOX when the air-fuel ratio of the flowing exhaust air is Lean. It is NOX, if it absorbs and an oxygen density falls. NOX to emit An absorption/emission action is performed.

[0018] In addition, an above-mentioned exhaust air air-fuel ratio is NOX here. The ratio of the sum total of an air content and the sum total of a fuel supplied to the flueway of the upstream of an absorbent 15, an engine combustion chamber, an inhalation-of-air path, etc., respectively shall be

meant. Therefore, NOX When a fuel (reducing agent) or air is not supplied to the upstream flueway of an absorbent 15, an exhaust air air-fuel ratio becomes equal to an engine operation air-fuel ratio (air-fuel ratio in combustion of an engine combustion chamber).

[0019] Since the diesel power plant is used in this example, the exhaust air air-fuel ratio at the time of operation is usually Lean, and it is NOX. An absorbent 15 is NOX under exhaust air. It absorbs. Moreover, if a reducing agent is introduced by the below-mentioned actuation during exhaust air and an oxygen density falls, the NOX absorbent 15 will emit the absorbed reducing agent. There is also a part which is not clear about the detailed mechanism of this absorption/emission action. However, it is thought that this absorption/emission action is performed by the mechanism as shown in drawing 3 . Next, it is Platinum Pt on support about this mechanism. And barium Ba It becomes the same mechanism even if it uses other noble metals, alkali metal, an alkaline earth, and rare earth, although explained taking the case of the case where it is made to support.

[0020] That is, if inflow exhaust air becomes Lean considerably, the oxygen density under inflow exhaust air will increase sharply, and it is drawing 3 (A). It is these oxygen O2 so that it may be shown. O2 - It is Platinum Pt in a form. It adheres to a front face. On the other hand, NO under inflow exhaust air is Platinum Pt. It is O2 on a front face. - It reacts and is set to NO2 (2 NO+O2 ->2NO2). Subsequently, generated NO2 A part is drawing 3 (A), being absorbed in an absorbent and combining with the barium oxide BaO oxidizing on Platinum Pt. It is nitrate ion NO3 so that it may be shown. - It is spread in an absorbent in a form. Thus, NOx NOx It is absorbed in an absorbent 15.

[0021] Therefore, it is Platinum Pt as long as the oxygen density under inflow exhaust air is high. It is NO2 in a front face. It is generated and is NOx of an absorbent. It is NO2 unless absorptance is saturated. It is absorbed in an absorbent and is nitrate ion NO3. - It is generated. On the other hand, the oxygen density under inflow exhaust air falls, and it is NO2. When the amount of generation decreases, a reaction goes to hard flow (NO3-->NO2), and it is the nitrate ion NO3 in an absorbent in this way. - NO2 It is emitted from an absorbent in a form. That is, it is NOx if the oxygen density under inflow exhaust air falls. An absorbent 15 to NOx It will be emitted.

[0022] On the other hand, these components are Platinum Pt if reduction components, such as HC and CO, exist during inflow exhaust air. Upper oxygen O2 - It reacts and oxidizes, the oxygen under exhaust air is consumed, and the oxygen density under exhaust air is reduced. Moreover, it is NOX by the oxygen density fall under exhaust air. NO2 emitted from the absorbent 15 Drawing 3 (B) It reacts with HC and CO and is returned so that it may be shown. Thus, platinum Pt It is NO2 on a front face. When it stops existing, it is NO2 from an absorbent to the degree from a degree. It is emitted. Therefore, it is Platinum Pt to the inside of a short time, so that HC under inflow exhaust air and CO component increase. Upper oxygen O2 - Consumption of the oxygen under exhaust air is performed and it is NOx at a short time from the NOx absorbent 15. It will be emitted and returned.

[0023] That is, HC under inflow exhaust air and CO are Platinum Pt first. O2 [upper] - It reacts immediately, oxidizes and, subsequently is Platinum Pt. O2 [upper] - NOx emitted by this HC and CO from the absorbent when HC and CO still remained, even if consumed And NOx discharged by the engine It is returned. therefore, under engine operation -- NOX in order to perform emission and reduction -- NOX the amount of the reducing agent which should be supplied to an absorbent -- dilution and Platinum Pt of (1) exhaust air fully reducing the oxygen density under exhaust air by the oxygen consumption by the upper oxidation -- a complement and (2) NOX the total emitted from an absorbent 15 -- NOX It becomes the sum total with a complement returning.

[0024] Moreover, NOX In order to make playback by emission and reduction complete for a short time, it is NOX as mentioned above. As the concentration of the reducing agent in an absorbent always becomes above to some extent, reduction of NOX is promoted, and it is NOX. NOX from an absorbent It is necessary to increase an emission rate. Therefore, NOX In order to shorten the playback time amount of an absorbent, it is NOX about the reducing agent of the above-mentioned initial complement. It must supply by flow rate to which the concentration of the reducing agent in an absorbent always becomes above to some extent. On the other hand, it is NOX. The amount of the reducing agent supplied to an absorbent exceeds the above (1) and the sum total of (2), and it is NOX. If the air-fuel ratio of the exhaust air which flows into an absorbent becomes rich sharply, components, such as HC of a reducing agent and CO, are NOX. In being emitted to atmospheric air as it is, without oxidizing with an absorbent ****, it is NOX. The problem which generates ammonia

with an absorbent arises.
[0025] However, it is NOX by adjusting the reducing-agent amount of supply, since there are problems, such as wall surface adhesion of a reducing agent, as mentioned above when a liquefied reducing agent is used. It is difficult to control the concentration (exhaust air air-fuel ratio) of the reducing agent which flows into an absorbent with a precision sufficient in the proper range. So, at this example, it is NOX. It is controlling by adjusting the amount of installation of the secondary air rather than adjusting the reducing-agent amount of supply and controlling the air-fuel ratio of exhaust air at the time of absorbent playback. That is, as a reducing agent supplies the superfluous amount beyond the above (1) and the sum total of (2) in this example, detailed control of the amount of supply is not performed, but it is NOX. It is based on the oxygen density detected by the oxygen density sensor 10 of absorbent 15 outlet, and is NOX. Feedback control of the amount of secondary airs is carried out so that the exhaust air air-fuel ratio which flows into an absorbent may become a predetermined value (for example, theoretical air fuel ratio).
[0026] Drawing 4 and drawing 5 are above NOX. An example of the flow chart of absorbent playback control is shown. This routine is performed by ECU20 for every fixed time amount. When a routine starts in drawing 4 , at step 401 Engine-speed N, The accelerator opening ACC and the engine exhaust-gas temperature TEX are NOX from each sensor. While the oxygen density ROX under exhaust air at an absorbent outlet is inputted from the oxygen density sensor 10, respectively NOX of the NOX absorbent which is calculated by the below-mentioned routine and stored in RAM22 An absorbed amount W is read and it is NOX based on these at step 403. It is judged whether the playback execution condition of an absorbent is satisfied.
[0027] Here, it is NOX. (1) accelerator opening ACC the playback execution condition of an absorbent Below a predetermined value And that engine-speed N is beyond a predetermined value (that is, an engine should be moderation operating), a thing [(2) engine exhaust-gas temperature TEX / beyond predetermined temperature], (3) NOX NOX of an absorbent It is that an absorbed amount W is more than the specified quantity etc., and only when the conditions of above-mentioned (1) - (3) are all satisfied, 405 or less-step NOX absorbent playback actuation is performed.
[0028] Here, it is NOX. Since it is necessary to close the inhalation-of-air shutter bulb 6 like the after-mentioned at the time of (above-mentioned condition (1)) and playback, and to reduce an inhalation air content, an absorbent 15 will be reproduced for producing a torque shock and operability getting worse only at the time of engine moderation, if it usually reproduces during operation. Moreover, it is NOX which an exhaust-gas temperature carries out to beyond a predetermined value (the above-mentioned conditions (2)). An absorbent is NOX. It is because it is required to have reached the activation temperature which emission and a reduction operation activate. Moreover, NOX NOX of an absorbent It is making for an absorbed amount to be more than the specified quantity (the above-mentioned conditions (3)) into a playback execution condition for avoiding frequent playback actuation, and performing playback actuation, only when playback is very required. In addition, the above NOX The predetermined value of an absorbed amount is NOX. NOX which an absorbent 15 may absorb It is carried out to about 30% of a peak.
[0029] It is NOX at step 403. When all absorbent playback conditions are satisfied, Counter C counts up plus 1 at step 405, and at step 407, it is judged for Counter C whether it is beyond the predetermined value CR. Here, Counter C is a counter corresponding to the elapsed time after playback conditions are satisfied at step 403, and the predetermined value CR is NOX. Playback time amount tR needed for completing playback of an absorbent It is a corresponding count of routine activation. Playback time amount tR NOX NOX in the type of an absorbent, and a playback execution condition It is the constant decided by setup (step 403, the above-mentioned conditions (3)) of the specified quantity of an absorbed amount etc. Since playback is completed when it is C>=CR at step 407 namely, it is NOX at step 409. NOX of an absorbent An absorbed amount W is set to zero, 431 or less step is performed, and playback actuation is ended.
[0030] When it is C<CR at step 407, it is 411 or less-step NOX. Absorbent playback actuation is performed. That is, at step 411, clausilium of the shutter bulb 6 of the engine inlet pipe 2 is carried out to predetermined opening. It is because there is no throttle valve in an inlet pipe and the amount of the reducing agent needed in order to reduce the oxygen density under exhaust air, if an inlet pipe is not extracted at the time of playback, since there are many inhalation air contents becomes

excessive by the diesel power plant. In addition, it is NOX of an exhaust air system about a means to replace with a shutter bulb in order to reduce the amount of a reducing agent, or to consume the oxygen under exhaust air of a burner etc. in addition to a shutter bulb. You may make it prepare in the absorbent upstream.

[0031] In order to prevent that rapid moderation produces the opening of a shutter bulb, it is beforehand set up as a function of an engine speed, and this function is stored in ROM23 of ECU20 in the form of a numerical table. The opening set point of the shutter bulb 6 is read from a numerical table based on an engine speed, the shutter valve actuator 7 is driven and the shutter bulb 6 is controlled by step 411 to predetermined opening so that the opening detected by the shutter bulb opening sensor 8 becomes equal to the above-mentioned set point. Subsequently, the reducing-agent amount of supply is determined at step 413. Namely, flow rate F1 of a reducing agent required in order to calculate the amount of oxygen under exhaust air from the oxygen density ROX under exhaust air read at step 401, and an engine inhalation air content and to consume the amount of oxygen It is computed. Furthermore, NOX read at step 401 NOX of an absorbent Amount WR of the reducing agent needed for returning an absorbed amount W It is calculated and is WR. Predetermined playback time amount tR It divides and is NOX. Reducing-agent flow rate F2 required to return an absorbed amount W It is computed. And the flow rate F of the reducing agent which should be supplied is determined as F=(F1+F2) xalpha.

[0032] Here, it is calculated from an engine speed and shutter bulb opening, and an engine inhalation air content is NOX. An absorbed amount W is calculated by the below-mentioned routine. Moreover, alpha is a larger constant than 1. That is, a reducing agent is supplied to playback from a complement at an excess. Subsequently, at step 415, the opening of reducing-agent injection valve 11a is set up so that the injection quantity F may be obtained, and a reducing agent is introduced into an exhaust pipe 3.

[0033] Moreover, at step 417, electric rotary pump 13a of a pulse air induction reactor 13 is turned ON, and the secondary air is introduced into an exhaust pipe 3. Subsequently, it progresses to drawing 5 and the opening of flow-control-valve 13c of a pulse air induction reactor 13 is adjusted according to the output of the oxygen density sensor 10 at steps 419-425. That is, if it is judged whether it is beyond the predetermined value Rst and the exhaust air oxygen density ROX read at step 401 in step 419 is ROX>=Rst, it is the opening VA of flow-control-valve 13c at step 421. Only the predetermined value beta is reduced. Moreover, if it is ROX<Rst, it is the opening VA of flow-control-valve 13c at step 423. Only beta increases. Thereby, it is the opening VA of flow-control-valve 13c. It is controlled so that the output ROX of the oxygen density sensor 10 becomes the predetermined value Rst. In this example, the above-mentioned predetermined value Rst is set as the oxygen density which gives theoretical air fuel ratio. Opening VA set up by the above at step 425 It outputs to actuator 13b of flow-control-valve 13c, and a routine is ended.

[0034] In addition, above-mentioned drawing 4 and playback time amount tR predetermined at step 407 If it passes or a playback execution condition stops satisfying at step 403, step 439 will be performed from drawing 5 and step 431, zero reset of the counter C is carried out (step 431), the shutter bulb 6 is made full open (step 433), installation of reducing-agent supply and the secondary air is suspended (steps 435, 437, and 439), and playback actuation stops.

[0035] As mentioned above, it is NOX, in order to supply a reducing agent superfluously and for adjustment of the amount of installation of the secondary air to perform control of an exhaust air air-fuel ratio in this example. The reducing agent of amount sufficient related always for wall surface adhesion of a liquefied reducing agent is supplied to an absorbent, and it is NOX by the lack of a reducing agent. The situation where playback of an absorbent becomes inadequate is prevented. Moreover, NOX Since the exhaust air air-fuel ratio which flows into an absorbent is always maintained near the theoretical air fuel ratio, excessive HC and CO component are NOX. It oxidizes completely with an absorbent and is NOX in that excessive HC and CO component are emitted to atmospheric air ****. The problem by which ammonia is generated with an absorbent is prevented.

[0036] Next, NOX read into drawing 6 at the drawing 4 step 401 NOX of an absorbent The calculation routine of an absorbed amount W is shown. This routine is also performed for every fixed time amount by ECU20. If a routine starts in drawing 6 , at step 601, engine-speed N and the accelerator opening ACC will be inputted from each sensor. Subsequently, at step 603, it is NOX.

NOX of an absorbent An absorbed amount W is computed. NOX generated here in an engine combustion chamber since it is thought that an amount increases, so that an engine load becomes high, and an engine load is proportional to accelerator opening and a rotational frequency in a diesel power plant -- NOX NOX absorbed by the absorbent an amount W -- last time -- the time of routine activation -- comparing -- KxACCxN (K is a constant) only -- it is thought that it is increasing. Therefore, at step 603, it is NOX. An absorbed amount W is calculated as W<-W+KxACCxN.
[0037] Subsequently, NOX calculated by the above at step 605 An absorbed amount W is stored in RAM22, and ends this routine. In addition, it is NOX as mentioned above. An absorbed amount W is NOX. It will be set to zero if playback of an absorbent is completed (step 409). In addition, at the above-mentioned example, it is NOX. NOX absorbed by the absorbent The increment of an amount Although asked as KxACCxN (step 603), they are engine-speed N and the accelerator opening ACC and NOX. It asks for relation with increment deltaW of an absorbed amount beforehand. It stores in ROM23 of ECU20 as a numerical map of engine-speed N and the accelerator opening ACC, and you may make it read increment from ROM23 using engine-speed N and the accelerator opening ACC. Drawing 7 shows the routine equivalent to drawing 6 in this case. That is, if a routine starts, at step 701, engine-speed N and the accelerator opening ACC are inputted from each sensor, this engine-speed N and the accelerator opening ACC are used at step 703, and it is NOX from ROM23 of ECU20. NOX absorbed by the absorbent Increment deltaW of an amount is read. Subsequently, at step 705, it is NOX at the time of routine activation this time. NOX of an absorbent NOX which calculated the absorbed amount W as W<-W+K1 xdeltaW (K1 is a constant), and was calculated from the above at step 707 An absorbed amount W is stored in RAM22, and a routine is ended.
[0038] Moreover, in the above-mentioned example, it sets to drawing 4 and step 413, and they are the exhaust air oxygen densities ROX and NOX. NOX of an absorbent Although the reducing-agent amount of supply F is determined for every routine activation using an absorbed amount W, the reducing-agent amount of supply F is NOX. It is [that what is necessary is just superfluous to the complement] good for playback of an absorbent also as a constant rate big enough. Furthermore, although the case where an above-mentioned example used gas oil as a liquefied reducing agent was explained, this invention is not necessarily limited to this, and also when using other liquefied reducing agents, it can be applied. Furthermore, although the case where an above-mentioned example applies this invention to a diesel power plant is explained, this invention is applicable to a gasoline engine similarly.
[0039]
[Effect of the Invention] By supplying a reducing agent superfluously and having controlled the exhaust air air-fuel ratio by the amount of secondary airs, a liquefied reducing agent is used for the exhaust emission control device of this invention, without forming the special equipment for evaporation or atomization, and it is NOX. The responsibility and stability of reducing-agent supply control to an absorbent are raised, and it is NOX. Effective playback of an absorbent can be performed.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of this invention.
[Drawing 2] It is drawing showing the example which applied this invention to the diesel power plant.
[Drawing 3] NOX NOX of an absorbent It is drawing for explaining an absorption/emission action.
[Drawing 4] NOX It is a part of flow chart which shows playback actuation of an absorbent.
[Drawing 5] NOX It is a part of flow chart which shows playback actuation of an absorbent.
[Drawing 6] NOX NOX of an absorbent It is one example of the flow chart which shows absorbed amount calculation.
[Drawing 7] NOX NOX of an absorbent It is an example different from drawing 6 of the flow chart which shows absorbed amount calculation.
[Description of Notations]
1 -- Diesel power plant
2 -- Engine inlet pipe
3 -- Engine exhaust pipe
6 -- Shutter bulb
7 -- Actuator
8 -- Shutter bulb opening sensor
10 -- Oxygen density sensor
11 -- Reducing-agent feeder
11a -- Reducing-agent injection valve
13 -- Pulse air induction reactor
13c -- Flow control valve
15 -- NOX Absorbent
20 -- Electronic control unit (ECU)

[Translation done.]

* NOTICES *

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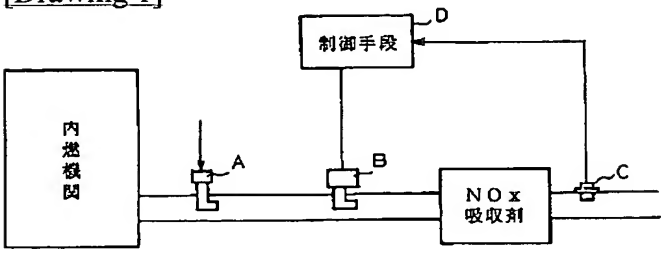
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

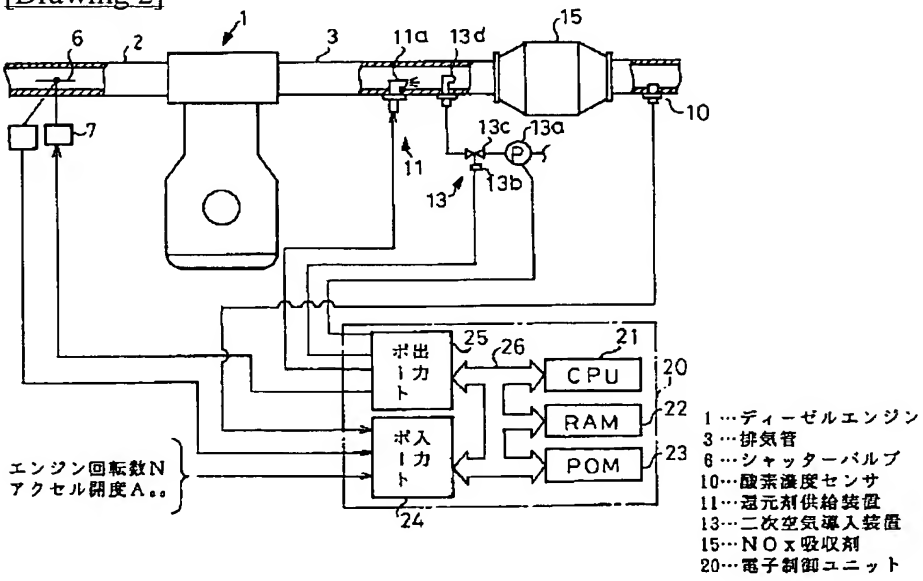
DRAWINGS

[Drawing 1]



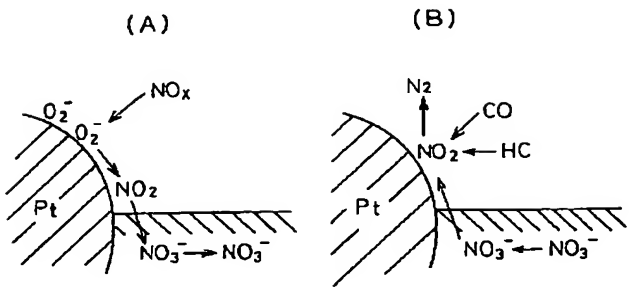
A…還元剤供給手段
B…二次空気導入手段
C…酸素濃度検出手段
D…制御手段

[Drawing 2]

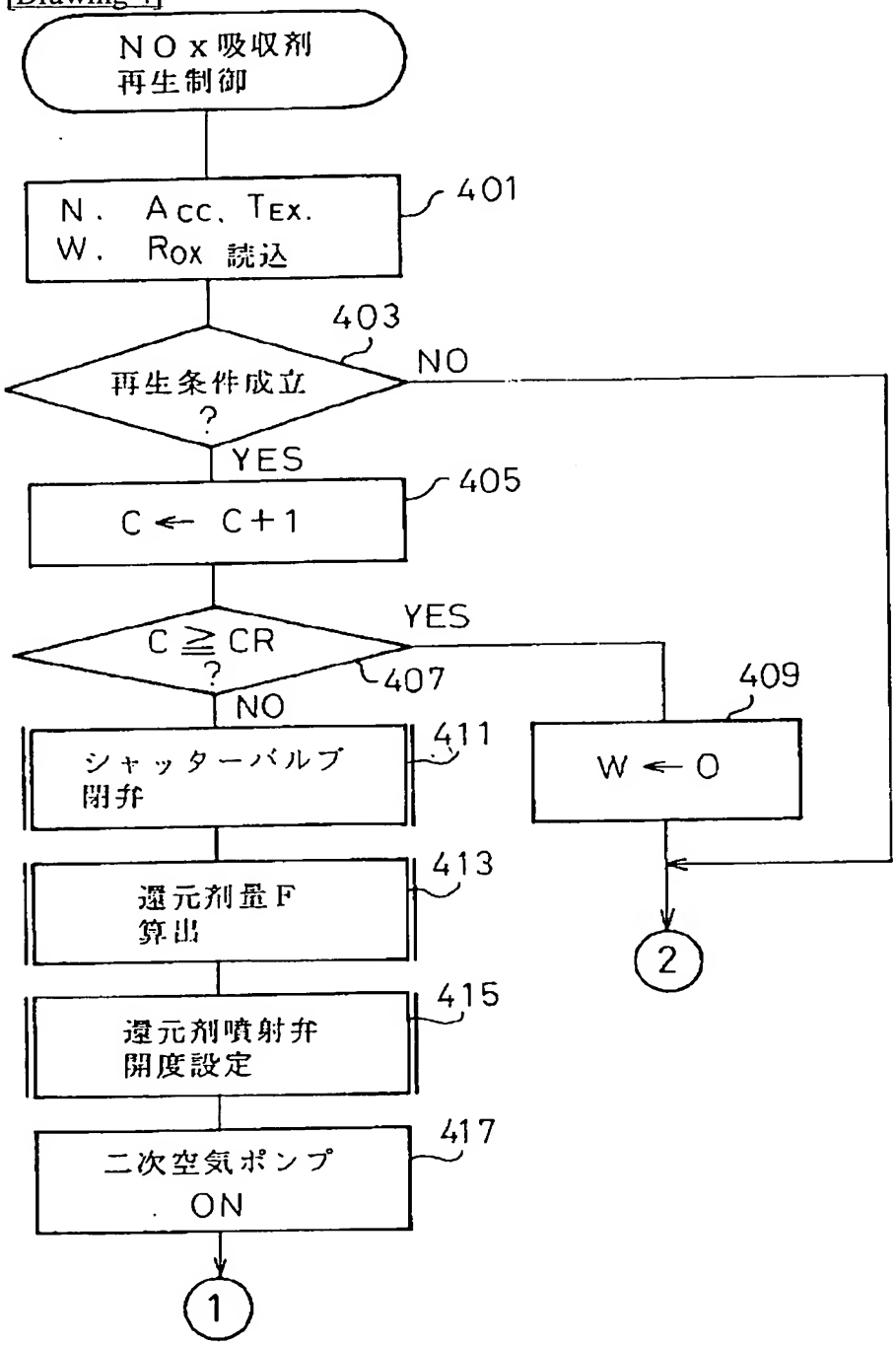


1…ディーゼルエンジン
3…排気管
6…シャッターバルブ
10…酸素濃度センサ
11…還元剤供給装置
13…二次空気導入装置
15…NOx吸収剤
20…電子制御ユニット

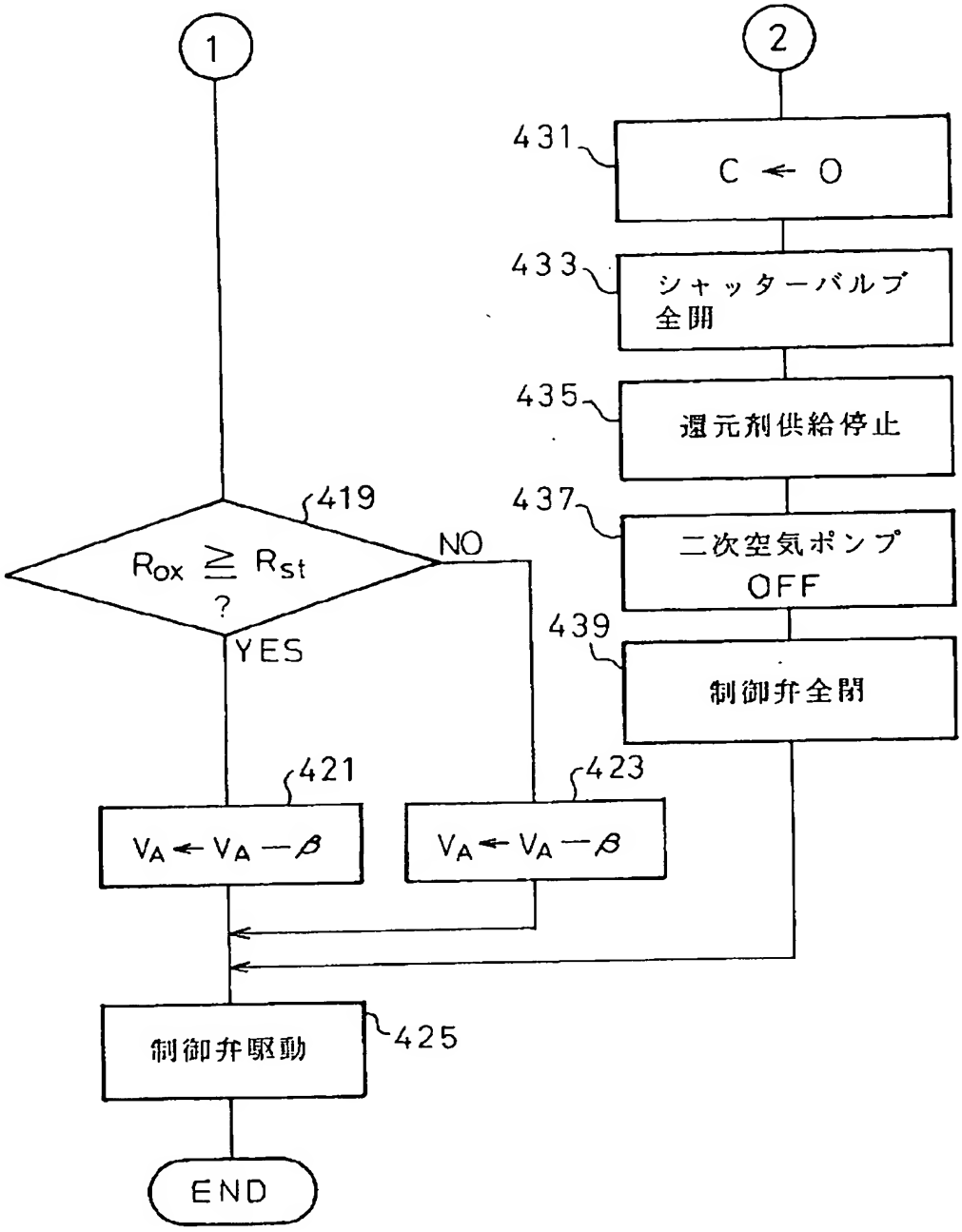
[Drawing 3]



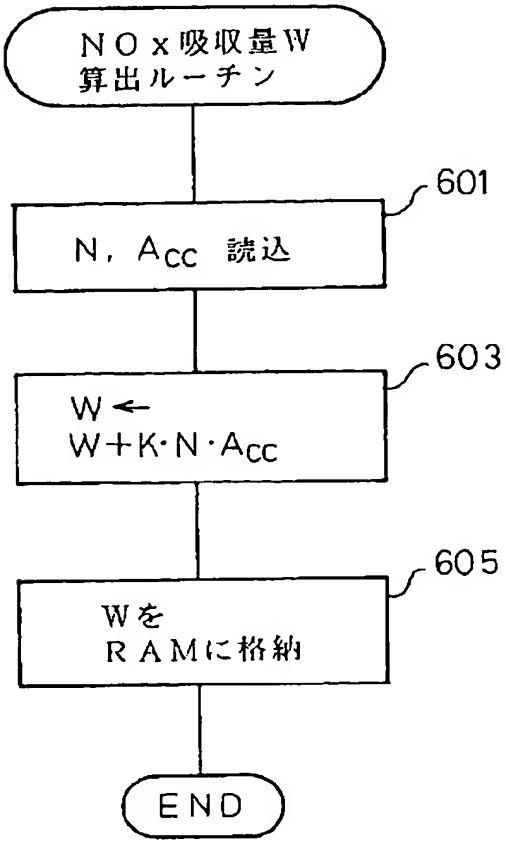
[Drawing 4]



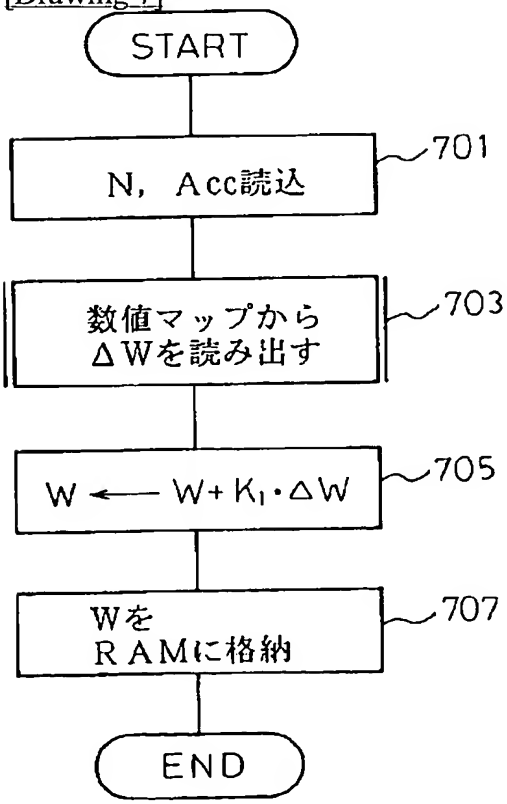
[Drawing 5]


1
2
431
C ← O
433
シャッターバルブ
全開
435
還元剤供給停止
437
二次空気ポンプ
OFF
439
制御弁全閉
419
Rox ≧ Rst
?
NO
YES
421
VA ← VA − β
423
VA ← VA − β
制御弁駆動
425
END

[Drawing 6]



[Drawing 7]



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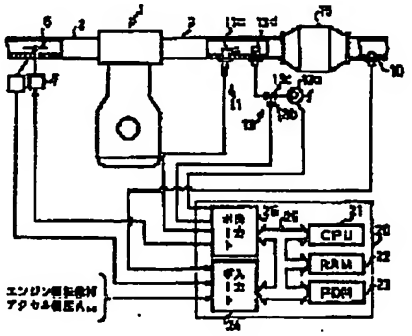
OBATA KIYOSHI

(54) EXHAUST EMISSION CONTROL SYSTEM FOR INTERNAL COMBUSTION ENGINE

(57) Abstract:

PURPOSE: To prevent responsiveness to reducer supply volume control for an NOx absorbent from deteriorating caused by reduce sticking to a wall surface if a liquid-like reducer is used, in an exhaust emission control system in which the NOx absorbent is located in an engine exhaust passage, and in which the reducer is fed into the NOx absorbent.

CONSTITUTION: A reducer supply device 11 and a secondary air introduction device 13 are provided in an exhaust passage 3, upstream of an NOx absorbent 15, and an oxygen density sensor 10 is located in the exhaust passage 3, downstream of the NOx absorbent 15. An electronic control unit 20 feeds a reducer by a supply volume in excess of a volume necessary for regeneration of the NOx absorbent 15, from a reduce supply device 11, and performs feed-back control of the air volume introduced from the secondary air introducing device 13 in accordance with an oxygen density detected by the oxygen density sensor 10 so as to set the air-fuel ratio of exhaust gas flowing into the NOx absorbent 15 is maintained in a predetermined range. Since the density of the reducer in the NOx absorbent is controlled by the secondary air volume, the control responsiveness and the control stability can be enhanced in comparison with such control that the density of the reducer is controlled by the reducer supply device 11.



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		Ａ			
	3/22	３０１	Ｇ		
		３１１	Ｌ		

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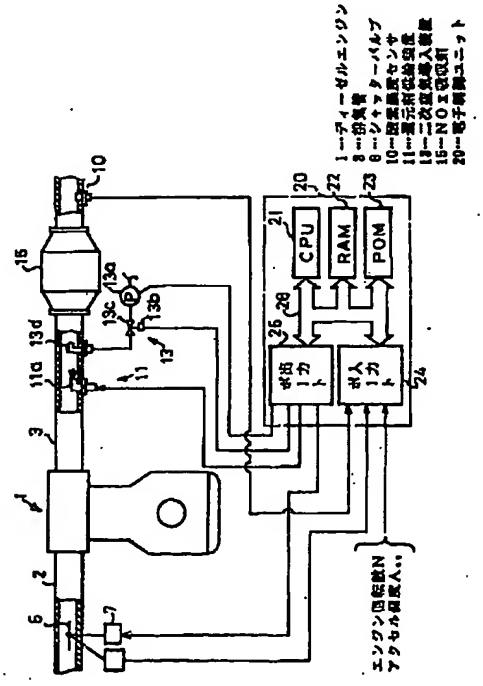
(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】　（修正有）

【目的】　機関排気通路にNO_x吸収剤を配置すると共に、還元剤をNO_x吸収剤に供給する排気浄化装置において、液状還元剤を使用した場合の還元剤の壁面付着によるNO_x吸収剤への還元剤供給量制御の応答性の悪化を防止する。

【構成】　NO_x吸収剤１５上流側の排気通路３に、還元剤供給装置１１と、二次空気導入装置１３とを設け、NO_x吸収剤の下流側に酸素濃度センサ１０を配置する。電子制御ユニット２０は、還元剤供給装置からNO_x吸収剤再生に必要な量よりも過剰な量の還元剤供給量を供給すると共に、酸素濃度センサにより検出された酸素濃度に基づいてNO_x吸収剤に流入する排気の空燃比が所定範囲になるように二次空気導入装置から導入する空気量をフィードバック制御する。NO_x吸収剤での還元剤の濃度は二次空気量により制御されるため、還元剤供給装置により還元剤濃度を制御する場合に較べて制御の応答性と安定性が向上する。



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【特許請求の範囲】

【請求項１】　少なくとも大部分の機関運転領域においてリーン空燃比の燃焼を行う内燃機関の排気通路に、流入排気の空燃比がリーンのときにNO_xを吸収し、流入排気の酸素濃度が低下したときに吸収したNO_xを放出するNO_x吸収剤を配置し、所定の運転条件下で排気中に還元剤を導入して前記NO_x吸収剤から吸収したNO_xを放出させると共に該NO_xを還元浄化する内燃機関の排気浄化装置において、前記NO_x吸収剤に、少なくとも吸収したNO_xの還元浄化に必要とされる以上の量の還元剤を供給する還元剤供給手段と、前記還元剤供給時に前記NO_x吸収剤上流側の排気通路に二次空気を導入する二次空気導入手段と、前記NO_x吸収剤下流側の排気中の酸素濃度を検出する酸素濃度検出手段と、検出された酸素濃度に基づいて前記二次空気導入手段の二次空気量を調整して前記NO_x吸収剤に流入する排気の空燃比を所定範囲に制御する制御手段とを備えたことを特徴とする内燃機関の排気浄化装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、内燃機関の排気浄化装置に関し、詳細には、ディーゼルエンジンや希薄燃焼を行うガソリンエンジン等、大部分の運転領域においてリーン空燃比の燃焼を行う内燃機関の排気中のNO_xを効果的に除去可能な排気浄化装置に関する。

【０００２】

【従来の技術】この種の排気浄化装置の例としては、例えば特開昭６２－１０６８２６号公報に開示されたものがある。同公報の装置は、ディーゼル機関の排気通路に酸素の存在下でNO_xを吸収する吸収剤（触媒）を配置して排気中のNO_xを吸収させ、該吸収剤のNO_x吸収効率が低下した場合に吸収剤への排気の流入を遮断して吸収剤に気体状の還元剤を供給することにより、吸収剤からNO_xを放出させると共に、放出されたNO_xを還元浄化するものである。

【０００３】

【発明が解決しようとする課題】上記特開昭６２－１０６８２６号公報の排気浄化装置では、NO_x吸収剤からのNO_xの放出と還元浄化（以下「再生」という）を行うために、水素等の気体状還元剤をNO_x吸収剤に供給している。しかし、水素等の気体状の還元剤は貯蔵に際して特別な容器を必要とする等、取扱が困難な問題があり、特に車両用内燃機関に使用する場合には種々の問題を生じる。

【０００４】従って、NO_x吸収剤の再生に用いる還元剤としては、当該内燃機関に使用するガソリン、軽油等の液体燃料をそのまま使用できることが好ましい。ところが、ガソリン、軽油等の液体燃料は沸点の異なる多くの成分を含んでおり、温度により気化する燃料の量が変化する。このため、これらの液体燃料をそのまま排気系

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に供給すると排気温度に応じて燃料の一部が気化せずに残り、液状のまま排気通路壁面に付着する問題を生じる。これらの壁面付着燃料も排気通路壁面を伝ってながれ、最終的にはNO_x吸収剤に到達して燃焼、気化する。しかし、NO_x吸収剤に到達するまでにはNO_x吸収剤までの距離や排気流速に応じて変わる到達時間が必要となるため、還元剤を排気系に注入してからNO_x吸収剤で所定量の還元剤が得られるまでに時間遅れが生じることになる。

【０００５】これを防止するために予め、壁面付着量を考慮して必要量以上の還元剤を排気系に注入して初期にNO_x吸収剤に到達する気化成分の量を増大させることも可能である。しかし、この場合壁面に付着した還元剤が上記遅れ時間経過後にNO_x吸収剤に到達すると還元剤の量が過剰になり、NO_x吸収剤部分での空燃比が過濃になるため、NO_x吸収剤でアンモニアが発生したり、還元剤のＨＣ、ＣＯ成分などが消費されずに大気に放出される恐れがある。

【０００６】このため、軽油等の液状還元剤を使用してNO_x吸収剤の再生を行う場合には、上述の還元剤の壁面付着とNO_x吸収剤への到達遅れを考慮してNO_x吸収剤に常に所定流量の還元剤が到達するように還元剤供給量を時間とともに変化させる必要がある。しかし、還元剤の壁面付着量やNO_x吸収剤への到達遅れ時間は、排気温度や排気流速などの運転条件により大きく変化する。したがって、液状還元剤を使用する場合にはこれらの条件に応じて還元剤供給量を細かく制御する必要が生じ、制御系統が複雑化する問題があり、また、還元剤供給量を正確に制御した場合であっても、上述の壁面付着による遅れ時間があるため制御の応答性や安定性を向上させることが困難な問題があった。

【０００７】予め、液状の還元剤を完全に気化させてから排気系に注入するか、壁面付着を生じない程度まで微粒化してから排気系に注入するようにすれば液状還元剤を使用する際の上記問題はある程度解決可能である。しかし、このためには、還元剤の気化や微粒化のための特別な機器を必要とするため、装置の複雑化やコストの増加を招く問題がある。

【０００８】本発明は、上記問題に鑑み、還元剤の気化や微粒化のための特別な装置を設けることなく上述の液状還元剤使用に関する問題を解決し、還元剤供給量制御の応答性と安定性を向上させてNO_x吸収剤の効率的な再生を行うことのできる排気浄化装置を提供することを目的としている。

【０００９】

【課題を解決するための手段】本発明によれば、図１の発明の構成図に示すように、少なくとも大部分の機関運転領域においてリーン空燃比の燃焼を行う内燃機関の排気通路に、流入排気の空燃比がリーンのときにNO_xを吸収し、流入排気の酸素濃度が低下したときに吸収した

NO_x を放出するNO_x 吸収剤を配置し、所定の運転条件下で排気中に還元剤を導入して前記NO_x 吸収剤から吸収したNO_x を放出させると共に該NO_x を還元浄化する内燃機関の排気浄化装置において、前記NO_x 吸収剤に、少なくとも吸収したNO_x の還元浄化に必要とされる以上の量の還元剤を供給する還元剤供給手段Aと、前記還元剤供給時に前記NO_x 吸収剤上流側の排気通路に二次空気を導入する二次空気導入手段Bと、前記NO_x 吸収剤下流側の排気中の酸素濃度を検出する酸素濃度検出手段Cと、検出された酸素濃度に基づいて前記二次空気導入手段の二次空気量を調整して前記NO_x 吸収剤に流入する排気の空燃比を所定範囲に制御する制御手段Dとを備えたことを特徴とする内燃機関の排気浄化装置が提供される。

【0010】

【作用】還元剤供給時には、還元剤供給手段Aは、常にNO_x 吸収剤再生に必要な量より過剰な還元剤を排気に導入し、精密な還元剤供給量の制御は行わない。制御手段Dは酸素濃度検出手段Cの検出した酸素濃度に基づいて、二次空気導入手段Bの導入空気量をフィードバック制御してNO_x 吸収剤に流入する排気の空燃比を所定範囲に維持する。これにより、壁面に付着する還元剤の量にかかわらずNO_x 吸収剤には常に必要量の還元剤が供給されると共にNO_x 吸収剤部分に流入する排気の空燃比制御の応答性と安定性が向上する。

【0011】

【実施例】図2を参照して、本発明をディーゼルエンジンに適用した場合の実施例について説明する。図2において、1はディーゼルエンジン、2はエンジンの吸気管、3はエンジンの排気管を示す。本実施例では、エンジンの吸気管2にはシャッターバルブ6が設けられている。

【0012】シャッターバルブ6は全開時の吸気抵抗の少ないバタフライ弁の形式であり、エンジンの通常運転時には全開に保持されており、後述のNO_x 吸収剤に吸収されたNO_x の放出、還元操作時に所定開度まで閉弁され、吸気管2を絞ってエンジンに吸入される空気量を低下させる。7は後述の電子制御ユニット（ECU）20からの信号を受けてシャッターバルブ6を開閉駆動するステップモータ、負圧アクチュエータなどの適宜な形式のアクチュエータ、8はシャッターバルブの開度を検出する開度センサである。

【0013】又、エンジン排気管3には還元剤供給装置11と、その下流側に二次空気導入装置13が配置されており、排気管3は、更にその下流部でNO_x 吸収剤15を収容したケーシングに接続されている。また、NO_x 吸収剤15出口の排気通路にはNO_x 吸収剤を通過する排気中の酸素濃度を検出する酸素濃度センサ10が設けられている。

【0014】還元剤供給装置11は、NO_x 吸収剤15の上流側の排気管3に還元剤を噴射する噴射弁11aを備え、ECU20からの入力信号に応じて所定の流量の還元剤を排気管3内に注入する。還元剤としては、排気中で炭化水素や一酸化炭素等の還元成分を発生するものであれば良く、プロパン、プロピレン、ブタン等の液体又は気体の炭化水素、ガソリン、軽油、灯油等の液体燃料等が使用できる。しかし、前述の理由から本実施例では還元剤としてエンジンの燃料と同じ軽油を使用しており、軽油は図示しないエンジンの燃料タンクから供給ポンプにより加圧されて噴射弁11aに供給される。

【0015】二次空気導入装置13は電動ポンプ等の加圧空気供給源13a、ステッパモータ等のアクチュエータ13bを有する流量制御弁13c、及びノズル13dを備えており、ECU20からの制御信号により流量制御弁13cのアクチュエータ13bを駆動して流量制御弁13cの開度を変え、ノズル13dから排気管3に導入する二次空気の流量を調節出来るようになっている。

【0016】酸素濃度センサ10には、排気中の酸素濃度に応じて連続的に変化する信号を出力するリーンミクスチャセンサが使用されている。但し、本実施例では、後述のように流量制御弁13cをON／OFF制御しているため、酸素濃度センサ10として理論空燃比近傍で出力が急変するタイプのセンサを使用してもよい。また、図に20で示すのはエンジン1の電子制御ユニット（ECU）である。ECU20はCPU21，RAM22，ROM23及び入力ポート24、出力ポート25を相互に双方向バス26で接続した構成のディジタルコンピュータからなり、エンジンの燃料噴射量制御等の基本制御を行うほか、本実施例ではNO_x 吸収剤の再生操作の制御等を行っている。これらの制御のためECU20の入力ポート24には、酸素濃度センサ10から排気中の酸素濃度信号が、またシャッターバルブ開度センサ8からシャッターバルブの開度信号が、それぞれ入力されている他、エンジン回転数、アクセル開度、排気温度信号等の信号がそれぞれ図示しないセンサから入力されている。

【0017】NOx 吸収剤15は例えばアルミナを担体とし、この担体上に例えばカリウムK，ナトリウムNa，リチウムLi，セシウムCs のようなアルカリ金属、バリウムBa，カルシウムCa のようなアルカリ土類、ランタンLa，イットリウムYのような希土類から選ばれた少なくとも一つと、白金Pt のような貴金属とが担持されている。このNO_x 吸収剤15は流入する排気の空燃比がリーンの場合にはNO_x を吸収し、酸素濃度が低下するとNO_x を放出するNO_x の吸放出作用を行う。

【0018】なお、上述の排気空燃比とは、ここではNO_x 吸収剤15の上流側の排気通路やエンジン燃焼室、吸気通路等にそれぞれ供給された空気量の合計と燃料の合計の比を意味するものとする。従って、NO_x 吸収剤

１５の上流側排気通路に燃料（還元剤）または空気が供給されない場合には排気空燃比はエンジンの運転空燃比（エンジン燃焼室内の燃焼における空燃比）と等しくなる。

【００１９】本実施例では、ディーゼルエンジンが使用されているため、通常運転時の排気空燃比はリーンであり、NO_x 吸収剤１５は排気中のNO_x の吸収を行う。また、後述の操作により排気中に還元剤が導入されて酸素濃度が低下すると、NO_x吸収剤１５は吸収した還元剤の放出を行う。この吸放出作用の詳細なメカニズムについては明らかでない部分もある。しかしながらこの吸放出作用は図３に示すようなメカニズムで行われているものと考えられる。次にこのメカニズムについて担体上に白金Ｐｔ およびバリウムＢａ を担持させた場合を例にとって説明するが他の貴金属、アルカリ金属、アルカリ土類、希土類を用いても同様なメカニズムとなる。

【００２０】即ち、流入排気がかなりリーンになると流入排気中の酸素濃度が大巾に増大し、図３(A) に示されるようにこれら酸素O_2 がO_2^- の形で白金Ｐｔ の表面に付着する。一方、流入排気中のNOは白金Ｐｔ の表面上でO_2^- と反応し、NO_2となる（$2NO+O_2 \rightarrow 2NO_2$）。次いで生成された$NO_2$ の一部は白金Ｐｔ上で酸化されつつ吸収剤内に吸収されて酸化バリウムＢａＯと結合しながら、図３(A) に示されるように硝酸イオンNO_3^- の形で吸収剤内に拡散する。このようにしてNOx がNOx 吸収剤１５内に吸収される。

【００２１】従って、流入排気中の酸素濃度が高い限り白金Ｐｔ の表面でNO_2 が生成され、吸収剤のNOx 吸収能力が飽和しない限りNO_2 が吸収剤内に吸収されて硝酸イオンNO_3^- が生成される。これに対して流入排気中の酸素濃度が低下してNO_2 の生成量が減少すると反応が逆方向（$NO_3^- \rightarrow NO_2$）に進み、こうして吸収剤内の硝酸イオンNO_3^- がNO_2 の形で吸収剤から放出される。即ち、流入排気中の酸素濃度が低下するとNOx 吸収剤１５からNOx が放出されることになる。

【００２２】一方、流入排気中にHC，ＣＯ等の還元成分が存在すると、これらの成分は白金Ｐｔ 上の酸素O_2^- と反応して酸化され、排気中の酸素を消費して排気中の酸素濃度を低下させる。また、排気中の酸素濃度低下によりNO_x 吸収剤１５から放出されたNO_2 は図３(B) に示すようにHC，ＣＯと反応して還元される。このようにして白金Ｐｔ の表面上にNO_2 が存在しなくなると吸収剤から次から次へとNO_2 が放出される。従って流入排気中のHC，ＣＯ成分が増加する程短時間のうちに白金Ｐｔ 上の酸素O_2^- と排気中の酸素の消費がおこなわれ、NOx吸収剤１５から短時間でNOx が放出され、還元されることになる。

【００２３】即ち、流入排気中のHC，ＣＯは、まず白金Ｐｔ 上のO_2^- とただちに反応して酸化され、次いで白金Ｐｔ 上のO_2^- が消費されてもまだHC，ＣＯが残っていればこのHC，ＣＯによって吸収剤から放出されたNOx および機関から排出されたNOx が還元される。従って、エンジン運転中にNO_x の放出、還元を行うためにNO_x 吸収剤に供給すべき還元剤の量は、（１）排気の希釈及び白金Ｐｔ 上での酸化による酸素消費により排気中の酸素濃度を充分に低下させるのに必要な量と、（２）NO_x 吸収剤１５から放出される全NO_x を還元するのに必要な量との合計となる。

【００２４】又、NO_x の放出、還元による再生を短時間で完了させるためには、上述のようにNO_x 吸収剤での還元剤の濃度が常にある程度以上になるようにしてNO_xの還元を促進し、NO_x 吸収剤からのNO_x 放出速度を増大する必要がある。従ってNO_x 吸収剤の再生時間を短縮するためには、上記必要量の還元剤を、NO_x 吸収剤での還元剤の濃度が常にある程度以上になるような流量で供給しなければならない。一方、NO_x 吸収剤に供給する還元剤の量が上記（１）と（２）の合計を越えてNO_x 吸収剤に流入する排気の空燃比が大幅にリッチになると、還元剤のHC，ＣＯ等の成分がNO_x 吸収剤で酸化されずにそのまま大気に放出されたり、NO_x 吸収剤でアンモニアを生成したりする問題が生じる。

【００２５】しかし、液状還元剤を使用した場合、前述のように還元剤の壁面付着等の問題があるため、還元剤供給量を調節することによってNO_x 吸収剤に流入する還元剤の濃度（排気空燃比）を適正な範囲に精度良く制御することは困難である。そこで、本実施例では、NO_x 吸収剤再生時に排気の空燃比を、還元剤供給量を調節して制御するのではなく二次空気の導入量を調節することにより制御している。すなわち、本実施例では、還元剤は上記（１）と（２）の合計を越えた過剰な量を供給するようにして供給量の微細な制御は行わず、NO_x 吸収剤１５出口の酸素濃度センサ１０で検出した酸素濃度に基づいてNO_x 吸収剤に流入する排気空燃比が所定値（例えば理論空燃比）になるように二次空気量をフィードバック制御しているのである。

【００２６】図４、図５は上記のNO_x 吸収剤再生制御のフローチャートの一例を示している。本ルーチンは一定時間毎にＥＣＵ２０により実行される。図４においてルーチンがスタートするとステップ４０１ではエンジン回転数N、アクセル開度A_{cc}、エンジン排気温度T_{ex}がそれぞれのセンサから、また、NO_x 吸収剤出口での排気中の酸素濃度R_{ox}が酸素濃度センサ１０からそれぞれ入力されると共に、後述のルーチンで計算されＲＡＭ２２に格納されているNO_x吸収剤のNO_x 吸収量Wが読み込まれ、ステップ４０３では、これらを基にNO_x 吸収剤の再生実行条件が成立しているか否かが判定される。

【００２７】ここで、NO_x 吸収剤の再生実行条件は、（１）アクセル開度A_{cc}が所定値以下、かつ、エンジン回転数Nが所定値以上であること（すなわちエンジンが

減速運転中であること）、（2）エンジン排気温度T_{ex}が所定温度以上であること、（3）NO_x吸収剤のNO$_x$吸収量Wが所定量以上であること、等であり、上記（1）～（3）の条件が全部成立した場合のみにステップ405以下のNO_x吸収剤再生操作を行う。

【0028】ここで、NO_x吸収剤15の再生をエンジン減速時にのみ行うのは（上記条件（1））、再生時には後述のように吸気シャッターバルブ6を閉じて吸入空気量を低減する必要があるため、通常運転中に再生を行うとトルクショックを生じ運転性が悪化するためである。また、排気温度が所定値以上（上記条件（2））とするのは、NO_x吸収剤がNO_xの放出、還元作用の活性化する活性化温度に達していることが必要だからである。また、NO_x吸収剤のNO$_x$吸収量が所定量以上であること（上記条件（3））を再生実行条件としているのは頻繁な再生操作を避けて真に再生が必要な場合にのみ再生操作を行うようにするためである。なお、上記NO$_x$吸収量の所定値は、例えばNO_x吸収剤15が吸収しうるNO_xの最大量の30パーセント程度とされる。

【0029】ステップ403でNO_x吸収剤再生条件が全て成立している場合ステップ405でカウンタCがプラス1カウントアップされ、ステップ407ではカウンタCが所定値CR以上か否かが判定される。ここで、カウンタCは、ステップ403で再生条件が成立してからの経過時間に対応するカウンタであり、所定値CRは、NO_x吸収剤の再生を完了するのに必要とされる再生時間t_sに相当するルーチン実行回数である。再生時間t_sはNO_x吸収剤のタイプ、再生実行条件におけるNO$_x$吸収量の所定量の設定（ステップ403、上記条件（3））等によって決まる定数である。ステップ407でC≧CRであった場合は、即ち再生が完了しているのでステップ409でNO_x吸収剤のNO$_x$吸収量Wをゼロにセットしてステップ431以下を実行して再生操作を終了する。

【0030】ステップ407でC＜CRであった場合は、ステップ411以下のNO_x吸収剤再生操作を実行する。すなわち、ステップ411では、エンジン吸気管2のシャッターバルブ6が所定の開度まで閉弁される。ディーゼルエンジンでは、吸気管にスロットル弁がなく吸入空気量が多いため再生時に吸気管を絞らないと排気中の酸素濃度を低下させるために必要とされる還元剤の量が過大になるためである。なお、還元剤の量を低減するためシャッターバルブに代えて、またはシャッターバルブに加えて、バーナ等の排気中の酸素を消費する手段を排気系のNO_x吸収剤上流側に設けるようにしてもよい。

【0031】シャッターバルブの開度は急激な減速が生じるのを防止するため、予めエンジン回転数の関数として設定されており、この関数はECU20のROM23に数値テーブルの形で格納されている。ステップ411では、エンジン回転数を基に数値テーブルからシャッターバルブ6の開度設定値を読みだし、シャッターバルブ開度センサ8で検出した開度が上記設定値に等しくなるようにシャッターバルブアクチュエータ7を駆動してシャッターバルブ6を所定開度に制御する。次いで、ステップ413では還元剤供給量が決定される。すなわち、ステップ401で読み込んだ排気中の酸素濃度R_{ox}とエンジン吸入空気量とから排気中の酸素量が計算され、その酸素量を消費するために必要な還元剤の流量F_1が算出される。更に、ステップ401で読み込んだNO$_x$吸収剤のNO$_x$吸収量Wを還元するのに必要とされる還元剤の量W_Rが計算され、W_Rを所定の再生時間t_sで割ってNO$_x$吸収量Wを還元するのに必要な還元剤流量F_2が算出される。そして、供給すべき還元剤の流量Fが、$F=(F_1+F_2)\times\alpha$として決定される。

【0032】ここで、エンジン吸入空気量はエンジン回転数とシャッターバルブ開度とから計算され、NO_x吸収量Wは後述のルーチンで計算される。また、αは1より大きい定数である。すなわち、還元剤は再生に必要な量より過剰に供給される。次いで、ステップ415では噴射量Fを得るように還元剤噴射弁11aの開度が設定され、還元剤が排気管3に導入される。

【0033】また、ステップ417では二次空気導入装置13の電動ポンプ13aがONにされ、二次空気が排気管3に導入される。次いで、図5に進み、ステップ419から425では二次空気導入装置13の流量制御弁13cの開度が酸素濃度センサ10の出力に応じて調整される。すなわち、ステップ419ではステップ401で読み込んだ排気酸素濃度R_{ox}が所定値R_{ox1}以上か否かが判定され、$R_{ox}\geq R_{ox1}$であればステップ421で流量制御弁13cの開度V_Aが所定値βだけ低減される。また、$R_{ox}<R_{ox1}$であれば、ステップ423で流量制御弁13cの開度V_Aがβだけ増大される。これにより、流量制御弁13cの開度V_Aは、酸素濃度センサ10の出力R_{ox}が所定値R_{ox1}になるように制御される。本実施例では、上記所定値R_{ox1}は、理論空燃比を与える酸素濃度に設定されている。ステップ425では、上記により設定した開度V_Aを流量制御弁13cのアクチュエータ13bに出力してルーチンを終了する。

【0034】なお、前述の図4、ステップ407で所定の再生時間t_sが経過するか、またはステップ403で再生実行条件が成立しなくなると図5、ステップ431からステップ439が実行され、カウンタCがゼロリセットされ（ステップ431）、シャッターバルブ6が全開にされ（ステップ433）、還元剤供給と二次空気の導入が停止され（ステップ435、437、439）、再生操作は停止される。

【0035】上述のように、本実施例では、還元剤を過剰に供給して；排気空燃比の制御は二次空気の導入量の調整で行うようにしているため、NO_x吸収剤には液状

還元剤の壁面付着に関係なく常に充分な量の還元剤が供給され、還元剤不足によりNO_x吸収剤の再生が不十分になる事態が防止される。また、NO_x吸収剤に流入する排気空燃比は常に理論空燃比近傍に維持されるので、余剰のHC、CO成分はNO_x吸収剤により完全に酸化され、余剰のHC、CO成分が大気に放出されたりNO_x吸収剤でアンモニアが生成されたりする問題が防止される。

【0036】次に、図6に図4ステップ401で読み込むNO_x吸収剤のNO_x吸収量Wの算出ルーチンを示す。本ルーチンもECU20により、一定時間毎に実行される。図6においてルーチンがスタートすると、ステップ601ではエンジン回転数N、アクセル開度A_{cc}がそれぞれのセンサから入力される。次いで、ステップ603ではNO_x吸収剤のNO_x吸収量Wが算出される。ここで、エンジン燃焼室で発生するNO_x量はエンジン負荷が高くなるほど増大し、エンジン負荷はディーゼルエンジンにおいてはアクセル開度と回転数に比例すると考えられるため、NO_x吸収剤に吸収されているNO_x量Wは前回ルーチン実行時に較べて、$K \times A_{cc} \times N$（Kは定数）だけ増加していると考えられる。従ってステップ603ではNO_x吸収量Wが、$W \leftarrow W + K \times A_{cc} \times N$として求められる。

【0037】次いで、ステップ605では上記により求めたNO_x吸収量WがRAM22に格納され、本ルーチンは終了する。なお、前述のように、NO_x吸収量WはNO_x吸収剤の再生が完了すると、ゼロにセットされる（ステップ409）。なお、上記実施例ではNO_x吸収剤に吸収されているNO_x量の増加分を、$K \times A_{cc} \times N$として求めたが（ステップ603）、エンジン回転数Nとアクセル開度A_{cc}とNO_x吸収量の増加分ΔWとの関係を予め求めておき、エンジン回転数Nとアクセル開度A_{cc}との数値マップとしてECU20のROM23に格納しておいて、エンジン回転数Nとアクセル開度A_{cc}とを用いてROM23から増加分を読み出すようにしてもよい。図7はこの場合の図6に相当するルーチンを示している。すなわち、ルーチンがスタートすると、ステップ701ではエンジン回転数N、アクセル開度A_{cc}がそれぞれのセンサから入力され、ステップ703ではこのエンジン回転数N、アクセル開度A_{cc}を用いてECU20のROM23からNO_x吸収剤に吸収されているNO_x量の増加分ΔWが読み出される。次いでステップ705では今回ルーチン実行時のNO_x吸収剤のNO_x吸収量Wを$W \leftarrow W + K_1 \times \Delta W$（$K_1$は定数）として求め、ステップ707では上記より求めたNO_x吸収量WをRAM22に格納してルーチンを終了する。

【0038】また、上述の実施例では図4、ステップ413において、排気酸素濃度R_{ox}とNO_x吸収剤のNO_x吸収量Wとを用いてルーチン実行毎に還元剤供給量Fを決定しているが、還元剤供給量FはNO_x吸収剤の再生に必要な量に対して過剰になっていれば良く、充分に大きな一定量としても良い。更に、上述の実施例は液状還元剤として軽油を使用する場合について説明したが、本発明は、これに限定されるわけではなく、他の液状還元剤を使用する場合にも適用可能である。更に、上述の実施例は本発明をディーゼルエンジンに適用した場合について説明しているが、本発明は、同様にガソリンエンジンにも適用可能である。

【0039】

【発明の効果】本発明の排気浄化装置は、還元剤を過剰に供給し、排気空燃比を二次空気量で制御するようにしたことにより、気化や微粒化のための特別な装置を設けることなく液状還元剤を用いてNO_x吸収剤への還元剤供給制御の応答性と安定性を向上させ、NO_x吸収剤の効果的な再生を行うことができる。

【図面の簡単な説明】

【図1】本発明の構成を示すブロック図である。

【図2】本発明をディーゼルエンジンに適用した実施例を示す図である。

【図3】NO_x吸収剤のNO_x吸放出作用を説明するための図である。

【図4】NO_x吸収剤の再生操作を示すフローチャートの一部である。

【図5】NO_x吸収剤の再生操作を示すフローチャートの一部である。

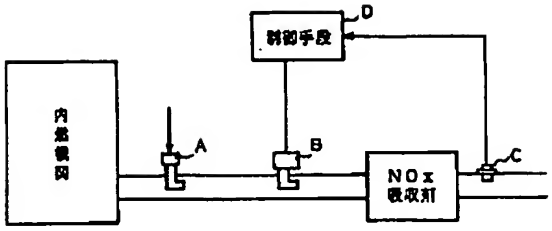
【図6】NO_x吸収剤のNO_x吸収量算出を示すフローチャートの一実施例である。

【図7】NO_x吸収剤のNO_x吸収量算出を示すフローチャートの図6とは別の実施例である。

【符号の説明】

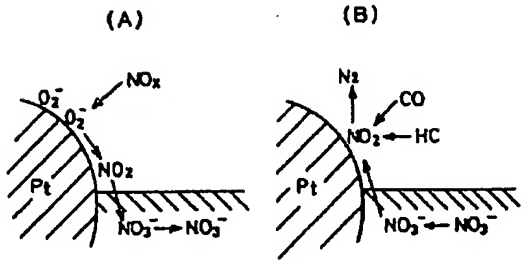
1…ディーゼルエンジン
2…エンジン吸気管
3…エンジン排気管
6…シャッターバルブ
7…アクチュエータ
8…シャッターバルブ開度センサ
10…酸素濃度センサ
11…還元剤供給装置
11a…還元剤噴射弁
13…二次空気導入装置
13c…流量制御弁
15…NO_x吸収剤
20…電子制御ユニット（ECU）

【図1】

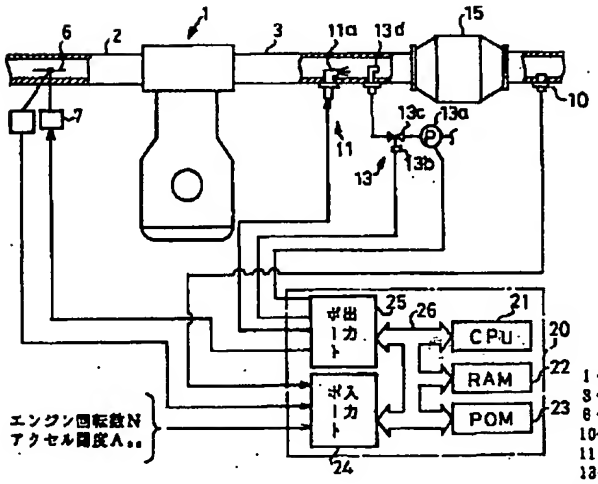


A…還元剤供給手段
B…二次空気導入手段
C…酸素濃度検出手段
D…制御手段

【図3】

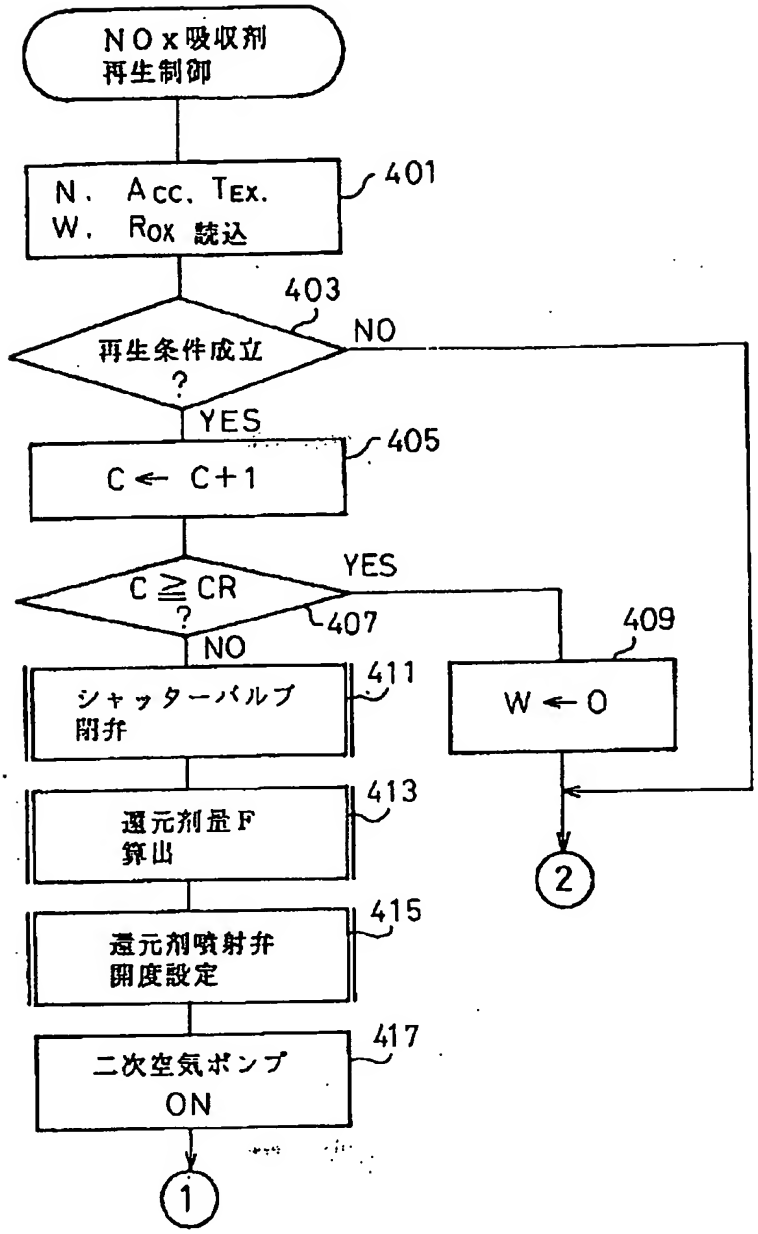


【図2】

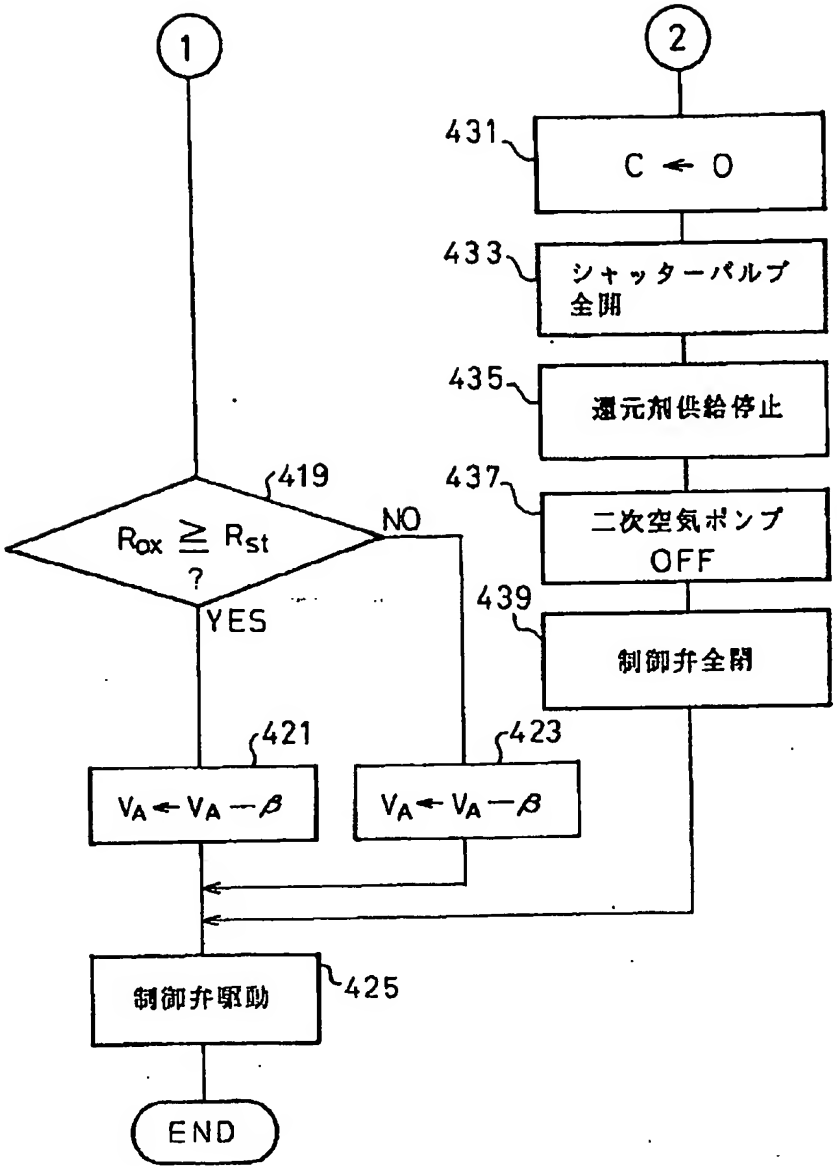


1…ディーゼルエンジン
3…排気管
6…シャッターバルブ
10…酸素濃度センサ
11…還元剤供給装置
13…二次空気導入装置
15…NOx吸収剤
20…電子制御ユニット

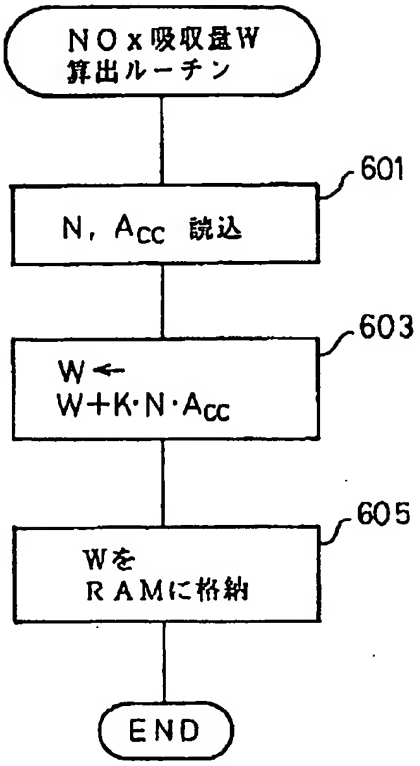
【図4】


NOx吸収剤
再生制御
N、Acc、TEx.
W、ROx 読込
401
403
再生条件成立
?
NO
YES
C← C+1
405
C≧CR
?
YES
407
NO
409
W← 0
シャッターバルブ
閉弁
411
還元剤量F
算出
413
還元剤噴射弁
開度設定
415
二次空気ポンプ
ON
417
2
1

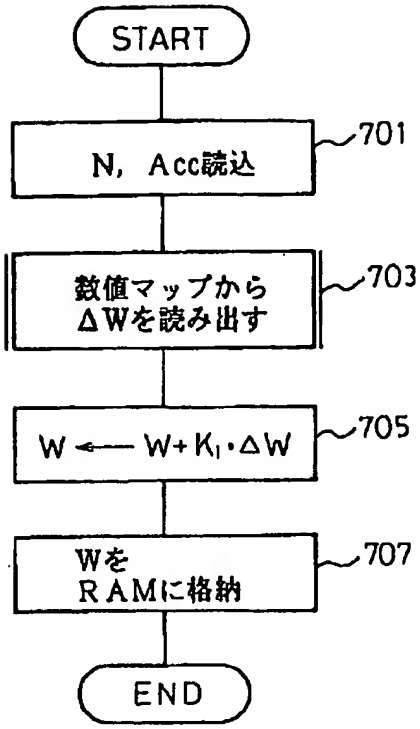
【図5】


1
2
431
C ← 0
433
シャッターバルブ
全開
435
還元剤供給停止
437
二次空気ポンプ
OFF
439
制御弁全閉
419
Rox ≧ Rst
?
NO
YES
421
VA ← VA − β
423
VA ← VA − β
制御弁駆動
425
END

【図6】


NOx吸収量W
算出ルーチン
601
N, Acc 読込
603
W←
W+K·N·Acc
605
Wを
RAMに格納
END

【図7】


START
701
N, Acc読込
703
数値マップから
ΔWを読み出す
705
W ← W+K1·ΔW
707
Wを
RAMに格納
END